PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Art Unit: 1742 Examiner: Alexander, M.	:	
In re application of	:	Title: Eglin Steel – A Low Alloy High Strength Composition
M. Dilmore et al.		
Serial No. 10/761,472		
Filed January 21, 2004	:	Attorney Docket 040650

DECLARATION OF JOHN PAULES
UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, John R. Paules, depose and say as follows:

1. I am employed as General Manager of Ellwood Materials Technologies, a subsidiary of Ellwood Group, Inc., the parent of Ellwood National Forge, Co., the present owner of the patent application referenced above (the "present application").

2. I earned B.S. and M.Eng.degrees in Metallurgy and Materials Science from Lehigh University in 1976 and 1981, respectively, and have worked in the field of steel metallurgy for 30 years. I am a registered Professional Engineer in the Commonwealth of Pennsylvania. I have worked with Eglin Steel, the low alloy steel described in the present application, for nine years. In particular, I am responsible for development of melting, forging, and heat treatment practices which result in mechanical properties and service performance which meet requirements. I have directed research studies of the fine scale microstructure of Eglin Steel to gain a full understanding of the effect of fine precipitate particles on properties such as strength and toughness. I have published and presented a technical paper on the development and properties of Eglin Steel.

3. On information and belief, the U.S. Patent Office issued an Office Action dated May 10, 2006, rejecting the claims of the present application based on the information disclosed in the following patent publications (the "Referenced Publications"):

U.S Patent No. 5,766,376 to Hasegawa;
U.S. Patent No. 6,494,970 to Ishii;
U.S. Patent No. 4,729,872 to Kishida;
Japanese Patent publication 09-194998 to Kenichi;
Korean abstract 1991-228317 to Lee; and,
U.S. Patent No. 2,942,339 to Lyon.
Table 1.1, Introduction to Steels and cast Irons

4. I have reviewed the present application, the May 10, 2006 Office Action and the Referenced Publications. Based on my experience in metallurgy and with high strength alloy steels in particular, it is my opinion that the comparison between Eglin Steel and the materials described in the Referenced Publications is misplaced.

5. A distinction between the Eglin Steel described in the present application and the steels described in the Referenced Publications is the modification of a relatively low-alloy NiCrMoV steel with relatively low carbon content via additions of about 1.0% Si and about 1.1% W. When given a special heat treatment, this steel produces an ultra-high strength level with high toughness and a large degree of strain hardening. This unique combination of properties is ideal for critical ordnance and high strength commercial applications.

6. As shown in Exhibit I, the Eglin Steel chemistry as shown in Table 2 and in Claim 2 of the present application differs significantly from the specific examples cited in referenced publications (i.e. Hasegawa, Ishii, Lee, Kenichi, and Kishida). Although there is overlap in the ranges described, the actual compositions used in the examples of the referenced publications and the manner of processing the substituents of the various alloys are quite different from the substituents of Eglin Steel and produce materials quite different from Eglin Steel for the following reasons.

a. Eglin Steel has about 1.0% Si. This is a much higher Si content than that actually used in the steels of the referenced publications. This elevated Si content is an essential

part of the Eglin Steel design because it allows low temperature tempering. Exhibits II and III show the important effects of an elevated Si content:

i. Exhibit II shows the strong effect of Si in retarding softening when tempering at the low temperature of 260°C (500°F).

ii. Exhibit III shows how an elevated Si content produces much better impact strength when steels are tempered at 260°C (500°F). An elevated Si content alters the formation of carbides during tempering at 260°C (500°F). Steels with normal (low) Si contents become embrittled when tempered at this temperature (a phenomenon called "Tempered Martensite Embrittlement'), while steels with elevated Si content achieve high impact strength.

b. Eglin Steel has about 0.28% Carbon, which is significantly higher than all of the other steels except Kishida's, which is at a much higher level of 0.39%.

c. Eglin Steel contains an elevated Nickel content of about 1.0% (for high toughness). None of the other steels (except some extreme examples cited by Hasegawa) use Nickel at the 1.0% level.

d. Eglin Steel has about 1.17% Tungsten, which enhances strength by forming stable tungsten carbide particles in the microstructure. None of the other steels use that amount of Tungsten.

7. The heat treatment used with Eglin Steel produces a unique combination of mechanical properties which is significantly different than that in the Referenced Publications. Eglin Steel is tempered at a low temperature of about 260°C (500°F) to produce a very high tensile strength level, typically about 1,725 MPa (ultimate tensile strength ranging from about 233 to 271 ksi and typically, about 245 ksi, as shown in Table 3 of the present application) and a Charpy V-notch impact strength, typically of at least about 20 ft.lbs. at -40°F (ranging from about 17 to 43 ft.lbs. at -40°F , as shown in Table 3 of the present application). The low tempering temperature also imparts a high degree of strain hardening (a low yield strength/tensile strength ratio). This strain hardening is an important feature which helps components such as penetrator bombs absorb high strain without fracturing. The steels described in the Referenced Publications are all tempered at significantly higher temperatures to produce lower strength levels. Even if the foregoing substituents were to be used in the amounts described in the ranges described, the final product produced would be different from Eglin Steel

and would have different properties than those of Eglin Steel because of the difference in the tempering temperature used, as shown in Exhibit I attached hereto.

8. None of the Referenced Publications describe the combination of low levels of Carbon, high levels of Silicon, high levels Tungsten and elevated levels of Nickel to produce a low alloy steel having the strength and toughness properties of Eglin Steel.

9. The Referenced Publications focus on a variety of features such as high temperature creep strength, weldability, and isotropic toughness. These features are developed for applications such as boiler tubes (Hasegawa and Kenichi), steam valves (Ishii), and hot working dies (Kishida). In contrast, Eglin Steel was specifically designed to achieve maximum strength, strain hardening, and impact toughness under dynamic loading conditions at ambient temperatures (i.e. to survive target penetration).

10. I further declare that all statements made herein are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any registration resulting therefrom.

John F Paules

John Paules

August 1, 2006

Date

Exhibit I.

	Eglin Steel	Hasegawa	Ishii	Lee	Kenichi	Kishida, cl. 6
Description	Ultra high strength	ferritic, heat resistant	heat resistant	High Tensile sheet	welded tube	Tool Steel
Product form	forgings	pipe	casting	steel sheet	welded tube	bar or forgings
Heat Treatment	quench & temper	normalize & temper	normalize & temper	quench & temper	quench & temper	quench and temper
Tempering Temp	500 F (Low)	1380 F (high)	high	1200 F (high)	1200 F (high)	high
Feature	High strength, toughness	creep strength	creep strength	?	weldability	isotropic toughness
Application	penetrator bombs	boiler tubes	steam valve	?	boiler tubes	hot working dies
Tensile Strength	1725 MPa	low	750 MPa	?	low	1480 MPa (Rc 45)
C min	0.16	0.01	0.15	0.05	0.01	0.30
C typical	**0.28**	**various**	**0.18**	**?**	**0.10**	**0.39**
C max	0.35	0.30	0.30	0.20	0.50	0.45
Mn min.	0.00	0.20	0.40	0.40	0.50	0.00
Mn typical	**0.74**	**various**	**0.50**	**?**	**1.30**	**0.41**
Mn max	0.85	1.50	0.70	3.00	2.00	2.00
Si min	0.00	0.02	0.10	0.08	0.00	0.00
Si typical	**1.00**	**<0.80**	**0.25**	**?**	**0.25**	**0.86**
Si max	1.25	0.80	0.30	1.00	1.00	2.00
Cr min	1.50	0.50	2.00	0.00	0.00	0.00
Cr typical	**2.75**	**various**	**2.20**	**?**	**0.12**	**5.25**
Cr max	3.25	5.00	2.50	3.00	3.00	7.00
Ni min	0.00	NS	0.00	0.00	0.00	NS
Ni typical	**1.03**	**various**	**0.40**	**?**	**0.25**	**NS**
Ni max	5.00	NS	0.20	3.00	1.50	4.00
Mo min	0.00	0.01	0.30	0.00	0.00	0.20
Mo typical	**0.36**	**various**	**0.60**	**?**	**0.05**	**1.38**
Mo max	0.55	1.50	0.80	1.00	1.50	12.00
W min	0.70	0.01	1.60	0.10	0.00	0.20
W typical	**1.17**	**various**	**2.00**	**?**	**0.01**	**NS**
W max	3.25	3.50	2.60	1.00	1.50	12.00
V min	0.05	0.02	0.23	0.00	0.00	0.00
V typical	**0.06**	**various**	**0.25**	**?**	**0.03**	**0.70**
V max	0.30	1.00	0.30	0.10	0.20	3.00
Co min	NS	0.20	NS	NS	NS	NS
Co typical	NS	various	NS	NS	NS	NS
Co max	NS	5.00	NS	NS	NS	6.50
Cu min	0.00	NS	NS	0.00	0.00	NS
Cu typical	**0.10**	**NS**	**NS**	**?**	**0.24**	**NS**
Cu max	0.50	NS	NS	0.80	1.50	NS
P min	0.000	0.000	0.000	0.000	0.000	NS
P typical	**0.012**	**various**	**0.008**	**?**	**0.012**	**NS**
P max	0.015	0.030	0.200	0.016	0.020	NS
S min	0.000		0.000	0.000	0.000	0.000
S typical	**0.003**	**various**	**0.001**	**?**	**0.002**	**0.002**
S max	0.012		0.200	0.005	0.030	0.005
Ca min	0.00			0.001	0.00	NS
Ca typical	**0.02**	**NS**	**NS**	**?**	**0.002**	**NS**
Ca max	0.02			0.10	0.01	
N min	0.000	0.001	0.005	0.000	0.000	NS
N typical	**0.007**	**NS**	**0.008**	**?**	**0.005**	**NS**
N max	0.140	0.060	0.030	0.005	0.010	0.200
Al min	0.000			0.000	0.000	NS
Al typical	**0.011**	**NS**	**NS**	**?**	**0.003**	**NS**
Al max	0.050			0.100	0.200	NS
Nb min	NS	0.010			0.000	NS
Nb typical	**NS**	various	**NS**		**0.020**	**NS**
Nb max	NS	0.500			0.200	NS
Ti and/or Zr	NS	0.001			0.000	NS
Ti/Zr typical	**NS**	**various**	**0.020**		**0.020**	**NS**
Ti and/or Zr	NS	0.800			0.200	NS
O min	NS	0.000				NS
O typical	**NS**	**NS**	**NS**		**NS**	**0.001**
O max	NS	0.020				NS
B min	NS	NS	0.001		0	NS
B typical	**NS**	**NS**	0.003		**0.0002**	**NS**
B max	NS	NS	0.004		0.005	NS

Exhibit II.

Source: R. A. Grange, C. R. Hribal, and L. F. Porter, "Hardness of Tempered Martensite in Carbon and Low-Alloy Steels", Metallurgical Transactions A, Vol. 8A, 1977, p 1775-1785.

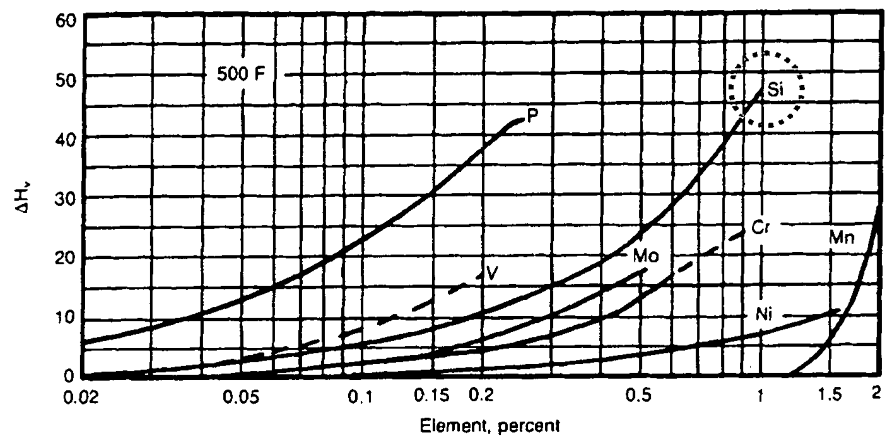

Fig. 17.9 Effect of alloying elements on the retardation of softening during tempering at 260 °C (500 °F) relative to Fe-C alloys. Source: Ref 17.5

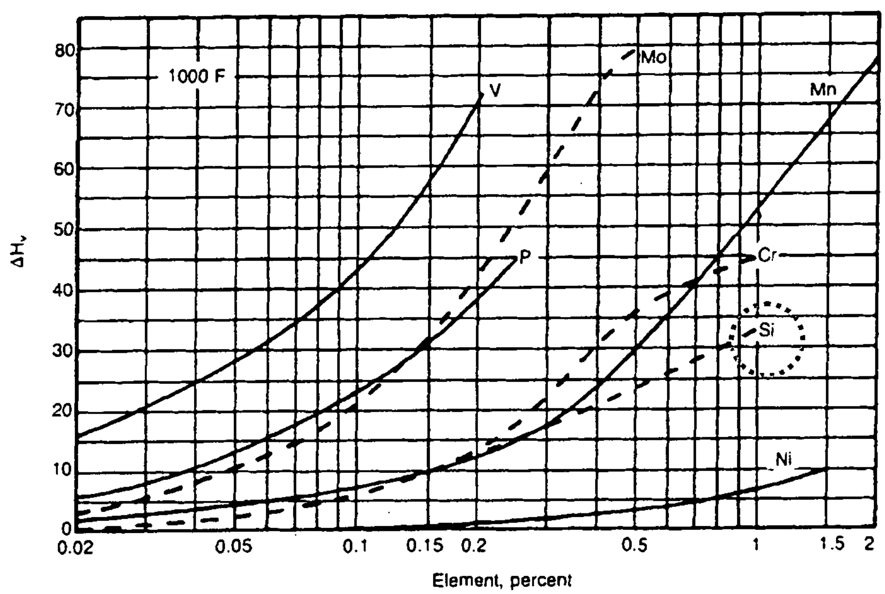

Fig. 17.10 Effect of alloying elements on the retardation of softening during tempering at 540 °C (1000 °F) relative to Fe-C alloys. Source: Ref 17.5

Exhibit III.

Source: Allten, A. G. and Payson, P., "The Effect of Silicon on the Tempering of Martensite", Transactions of ASM, Vol. 45, 1953, pp. 498-532.

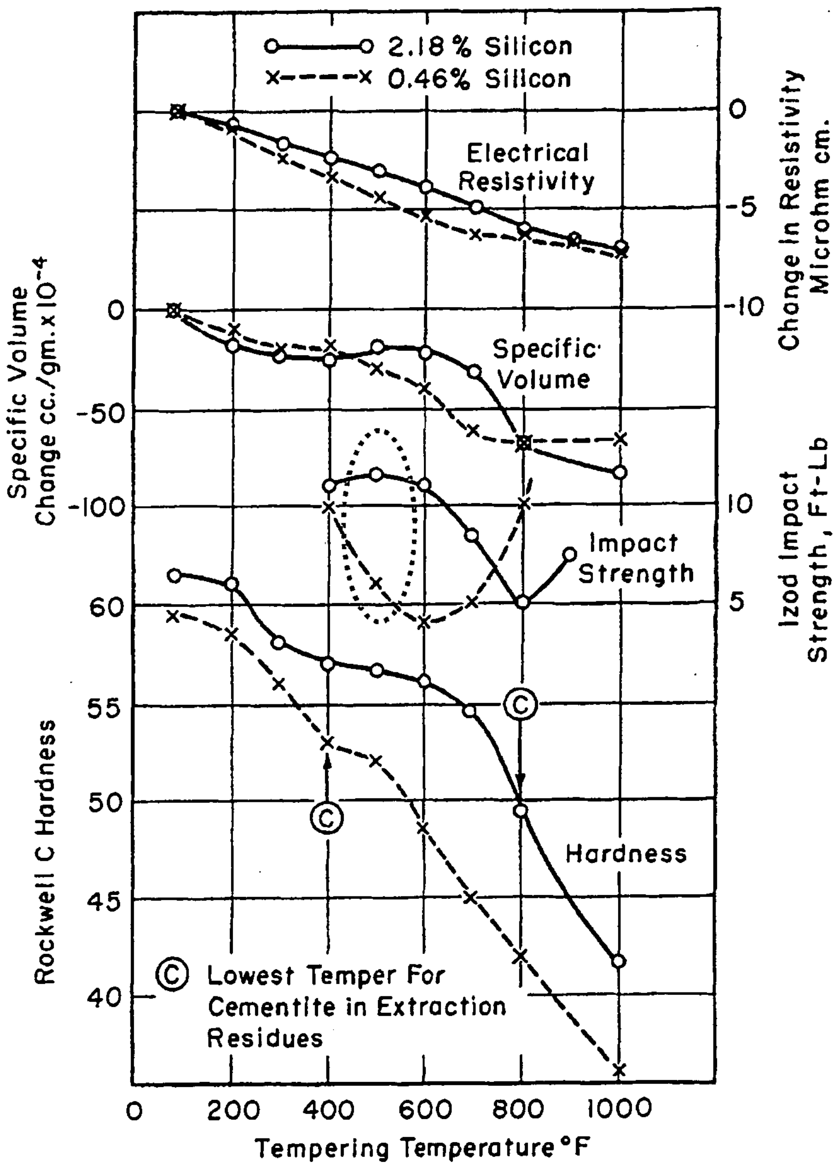

Fig. 14—Effect of Tempering Temperature on the Room Temperature Properties of 3% Nickel Steels Containing 0.5 and 2.2% Silicon—Hardened 1600 °F (870 °C), Oil-Quenched, Cooled to —320 °F (—195 °C); Tempered for 2-Hour Periods at the Indicated Temperatures.